THE SIMPSONS SPRINGFIELD UNIVERSITY GENETICS ACTIVITY

In this activity you will:

- Review the difference between homozygous and heterozygous genotypes
- Distinguish between purebred and hybrid genotypes
- Use genotypes to identify phenotypes
- Predict the genetic makeup of offspring using information given about the parents and Punnett squares

Introduction:

Scientists at Springfield University have decided to launch an investigation into the genetic makeup of certain Springfield citizens due to possible adverse effects from the Springfield Nuclear Power Plant. Use your knowledge of genetics and the given information to answer the following questions.

Questions:

1. For each of the genotypes given below, write whether it is heterozygous (HT) or homozygous (HM):

mixed

same

TT:	HM	Ff:	HT	Dd:	HT
Bb:	HT	tt:	HM	ff:	HM
DD:	HM	dd:	HM	Tt:	HT
bb:	HM	BB:	HM	FF:	HM

List the genotypes in question 1 that would be considered hybrids:

Bb, Ff, Dd, Tt

List the genotypes in question 1 that would be considered purebred:

TT, DD, BB, FF, ff, dd, bb, tt

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2. Determine the phenotype for each genotype using the information provided about Marge Simpson.

Blue hair color is dominant to yellow.
BB blue Bb blue bb yellow

Tall hair is dominant to short hair.
TT tall Tt tall tt short

3. For each phenotype, give the genotypes that are possible for Bart Simpson.

Round eyes (R) are dominant to square eyes (r).
Round = RR, Rr Square = rr

Spiked hair (S) is dominant to flat hair (s).
Spiked = SS, Ss Flat = ss

4. When Marge met Homer Simpson in high school, he was not bald. He had short hair. Marge is heterozygous for tall hair. Create a Punnett square to show the possibilities for hair height that resulted each time they had a child together. HINT: Read question #2!

tt ← TT

	t	t
T	Tt	Tt
t	tt	tt

List the genotypes and phenotype possibilities:
Tt = tall
tt = short

What are the chances of having a child with tall hair?
2 out of 4 or 50 %

What are the chances of having a child with short hair?
2 out of 4 or 50 %

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Rr

5. Bart wants to marry one of Lisa's friends. Both of them are heterozygous for round eyes, which is dominant over square eyes. Create a Punnett square to show the possibilities for eye shape that would result if they had a child together. HINT: Read question #3!

	R	r
R	RR	Rr
r	Rr	rr

List the genotypes and phenotype possibilities:

RR = round
Rr = round rr = square

What are the chances of having a child with round eyes?
__3__ out of __4__ or __75__%

What are the chances of having a child with square eyes?
__1__ out of __4__ or __25__%

6. Apu from the Quickie Mart is part of a family where everyone has an extra pinky toe. This is the dominant trait for the number of toes in his hometown village in his homeland. His family is very proud that they have descended from a royal "purebred" line of ancestry. He recently married a nice girl who works at the Super Drive-thru who has only five toes (no extra pinky) on each foot, which is a recessive trait. Create a Punnett square to show the possibilities that would result if Apu and his new wife had children. Use P to represent the dominant gene and p to represent the recessive gene.

= homozygous dominant

→ Pp

	P	p
p	Pp	Pp
p	Pp	Pp

List the genotypes and phenotype possibilities:

Pp = extra toe

What are the chances of having a child with extra toes?
__4__ out of __4__ or __100__%

What are the chances of having a child with no extra toes?
__0__ out of __4__ or __0__%

Would Apu's children still be purebreds? Explain!

No, because they all carry the recessive gene

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7. Assume that one of Apu's sons, who is heterozygous for the extra toe trait, married a girl that was also heterozygous. Create a Punnett square to show the possibilities that would result if they had children.

Pp

Pp

	P	p
P	PP	Pp
p	Pp	pp

List the genotypes and phenotype possibilities:

PP
Pp > extra toe pp = no extra toe

What are the chances of having a child with extra toes?
3 out of 4 or 75%

What are the chances of having a child with no extra toes?
1 out of 4 or 25%

8. Crusty the Clown and his wife Cristy recently brought home a new baby clown, but it was not a happy occasion for them. Cristy has been upset since she first saw her daughter, who has a blue nose. She feels that the hospital has goofed and mixed up her baby with some other clown family's. Crusty is homozygous for his red nose, while Cristy is heterozygous for her red nose. Some members of her family do have blue noses, which is the recessive trait. Create a Punnett square using R for the dominant trait and r for the recessive one.

RR

Rr

	R	r
R	RR	Rr
R	RR	Rr

List the genotypes and phenotype possibilities:

RR
Rr > red

Did the hospital make a mistake? Explain your answer.

Yes, because there is no possibility for the "rr" (blue) genotype.

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X-Linked Inheritance

★ Review X-linked inheritance and how the allele is passed from parents to children

Traits that are determined by alleles carried on the **X chromosome** are referred to as **X-linked**. X-linked alleles require a specific notation: X^C or X^+ where the "+" represents the **dominant** allele and the lowercase letter the **recessive** allele. Females will have two X-linked alleles (because females are XX), whereas males will only have one X-linked allele (because males are XY). Most X-linked traits in humans are recessive.

One example of an X-linked trait is red-green colorblindness. Let (X^C) represent the recessive allele that causes colorblindness and (X^+) represent the normal dominant allele. Females that are X^+X^+ or X^+X^C have normal color vision, while X^CX^C females are colorblind. Males that are X^+Y have normal color vision, while X^CY males are colorblind.

Punnett Squares

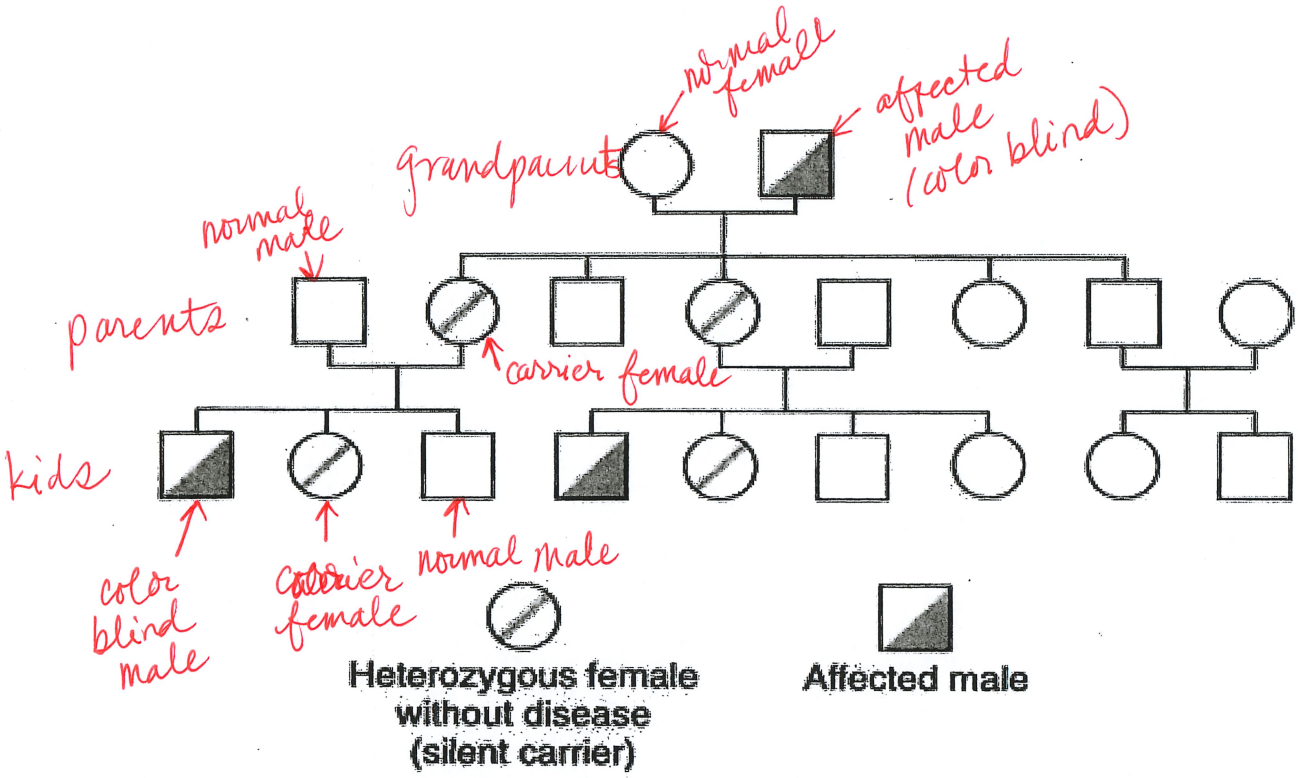
To determine the inheritance of red-green colorblindness (or any other X-linked trait), the genotypes of the parents must be considered.For example, if a mother is a **carrier** for colorblindness (X^+X^C), and a father has normal vision X^+Y, then their sons have a 50% chance of colorblindness because they inherit their X chromosome from their

	X^c	X^+
X^+	$X^c X^+$	X^+X^+
Y	X^cY	X^+Y

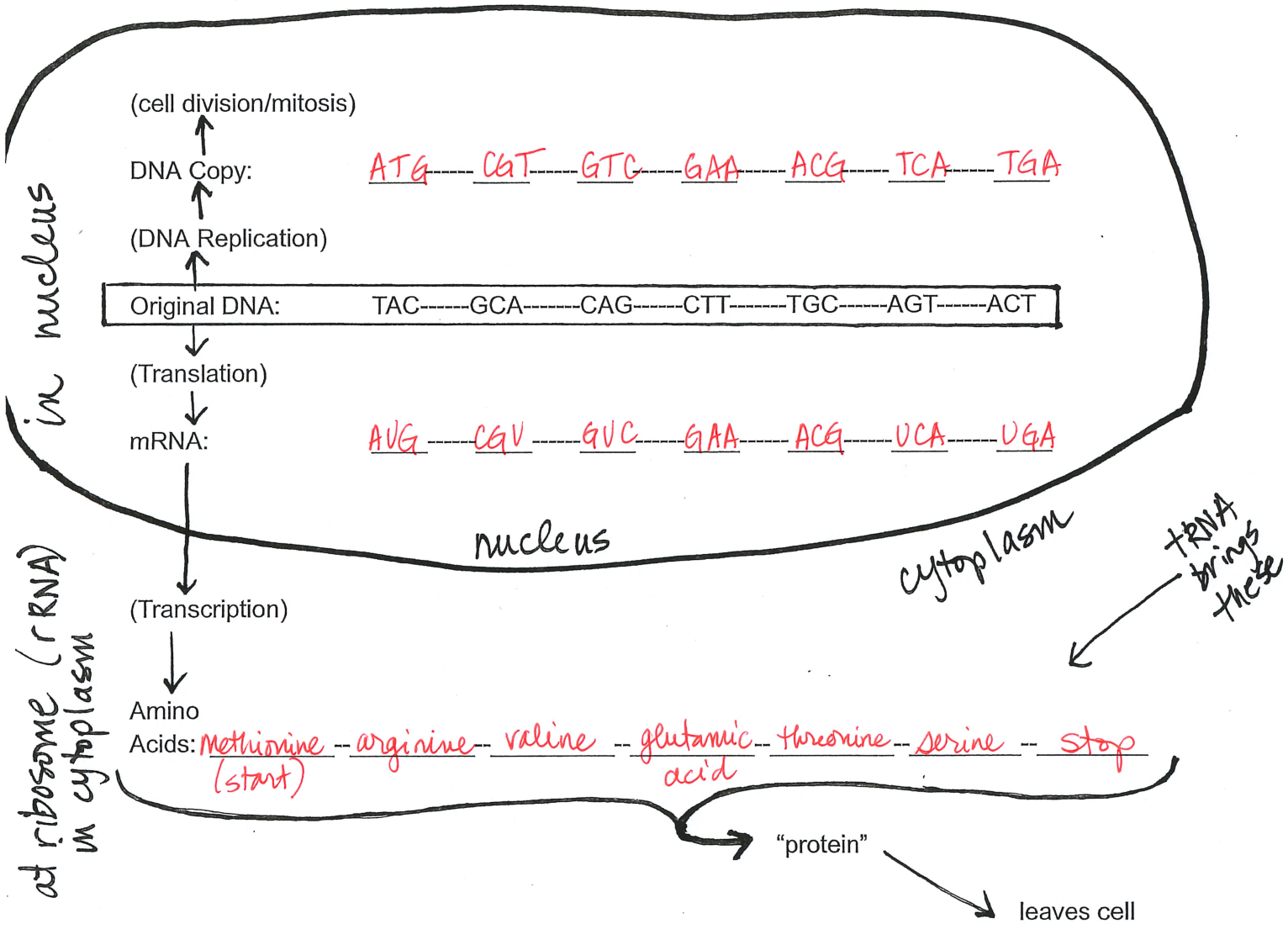
carrier

normal

mother and their Y chromosome from their father. Their daughters will have a 50% chance of being a carrier (X^+X^C) and a 50% chance of being completely normal (X^+X^+) (see figure). A Punnett square can be used to determine any possible genotypic combinations in the parents.



DNA Bases	Base Pairing:
A: Adenine	A pairs with T
T: Thymine	T pairs with A
G: Guanine	G pairs with C
C: Cytosine	C pairs with G

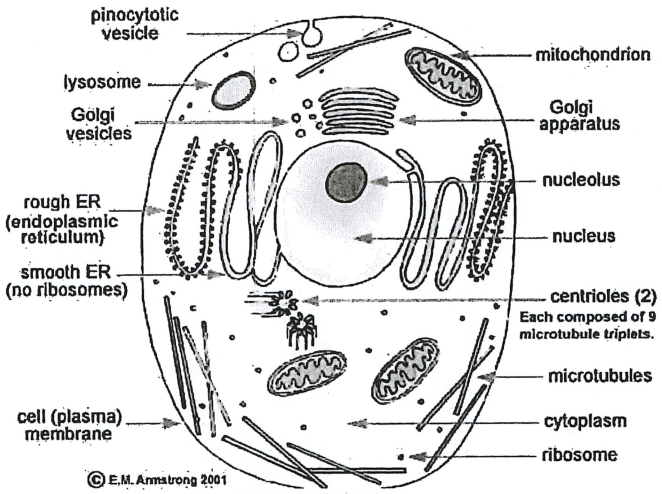


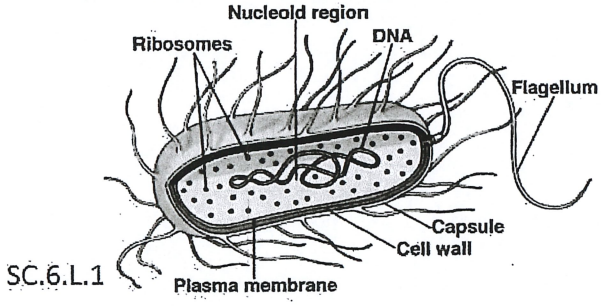
RNA Bases	Base Pairing:
A: Adenine	A pairs with U
U: Uracil	T pairs with A
G: Guanine	G pairs with C
C: Cytosine	C pairs with G

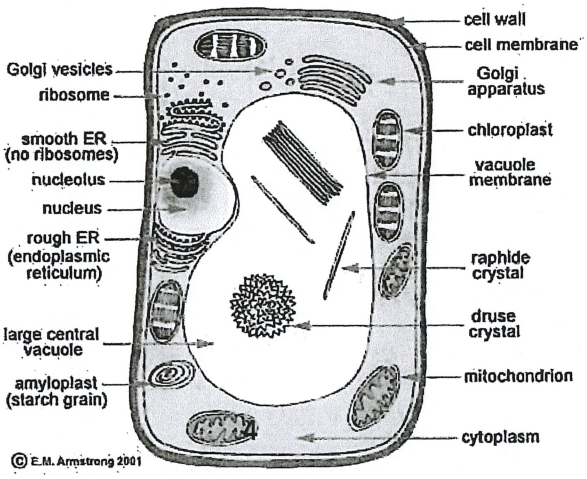
First Base	Second Base								Third Base
	U		C		A		G		
	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
U	UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine	C
	UUA	Leucine	UCA	Serine	UAA	Stop	UGA	Stop	A
	UUG	Leucine	UCG	Serine	UAG	Stop	UGG	Tryptophan	G
	CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine	U
C	CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine	C
	CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine	A
	CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine	G
	AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine	U
A	AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine	C
	AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine	A
	AUG	Methionine or start	ACG	Threonine	AAG	Lysine	AGG	Arginine	G
	GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine	U
G	GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine	C
	GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine	A
	GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine	G

Parts of a Cell

What are some key differences between plant cells, animal cells, and bacteria cells







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* Review cell organelles

* Review differences between types of cells

DIFFERENCES IN ANIMAL CELLS, PLANT CELLS, AND BACTERIA

ANIMAL CELL	PLANT CELL	BACTERIA
Eukaryotes	Eukaryotes	Prokaryotes
Cell membrane	Cell membrane	Cell membrane
Nuclear membrane	Nuclear membrane	NO nuclear membrane
NO cell wall	Cell wall made of CELLULOSE	Cell wall made of PEPTIDOGLYCAN
Has ribosomes	Has ribosomes	Has ribosomes
DNA in multiple chromosomes	DNA in multiple chromosomes	* DNA is a single circular ring
CYTOSKELETON	CYTOSKELETON	CYTOSKELETON
Small vacuoles	Really big vacuole*	NO vacuoles
Has lysosomes	Has lysosomes	NO lysosomes
Has centrioles	NO centrioles	NO centrioles
NO chloroplasts	* Chloroplasts	NO chloroplasts
SMALLER	SMALL	SMALLEST

* review the different types of cell transport

Cell Transport

Cell Membranes

- Are the outside covering of cells
- Let some things enter and leave the cell
- Don't let others in or out
- This is called "selectively permeable"

Diffusion

- When molecules move from more concentrated areas to less concentrated areas
- Due to random motion of particles

* no energy used

Equilibrium

- When the molecules are spread out evenly
- Concentrations are equal
- Molecules will diffuse until this happens

Osmosis

- The diffusion of water through a cell membrane
- Cells contain water inside membrane
- Surrounded by water outside membrane
- Water amount should be equal on both sides

In a cell…

- If water inside is LESS concentrated than outside, water enters the cell and the cell puffs up
- If water inside is MORE concentrated, water exits the cell and it shrivels up (usually salt or other material is outside)

more particles of a substance outside of a cell

more particles of a protein, sugar, etc inside the cell

Passive Transport

- When substances move through a cell membrane WITHOUT using cellular energy
- Types: Diffusion (water only)
  Facilitated Diffusion (other items)

Facilitated Diffusion

- Some substances are too big to pass through membrane on their own
- A protein helps out but no energy is used
- Still moves in or out due to high and low concentration

Active Transport

- Energy is required to move things in or out of the cell
- Movement goes AGAINST high and low concentration "rules"

Endocytosis

ENTER

- How large items enter the cell
- Membrane folds around item and pinches in
- "Bubble" holding item enters cell
- Some one-celled organisms eat this way

Exocytosis

EXIT

- How large items exit the cell
- Membrane of "bubble" fuses with cell membrane
- Item (ex: waste) leaves the cell